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# **SPECIAL TECHNOLOGY AREA REVIEW ON TIME AND FREQUENCY**

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A Special Technology Area Review (STAR) of frequency control technology was held by Working Group A of the Department of Defense (DoD) Advisory Group on Electron Devices in March 1995. The goal was to develop a DoD investment strategy for research and development (R&D) on frequency control devices. The STAR sought answers to questions such as:

What are the DoD system needs and how critical are these needs?

Are DoD's needs being met?

What are the commercial needs, and to what extent can commercially available devices meet DoD needs?

What is the total R&D activity in the field - in government, industrial and university laboratories?

What critical-path R&D and manufacturability problems need to be solved, if any? Are there any "showstoppers"? What is the probability that solutions will be found? What will the solutions cost? What are the trade-offs if solutions are not developed?

What are the emerging technologies? To what extent can these technologies contribute to DoD capabilities in the future?

Are these technologies being adequately developed? If not, what would it cost? Who are the key organizations to make it happen?

What is the industrial base, and is the industrial base adequate for meeting the future R&D and manufacturing requirements of DoD?

What should be the role of DoD in this technology area?

The conclusions and recommendations of this STAR are described in a report entitled "Special Technology Area Review on Frequency Control Devices." The report is available from:

Advisory Group on Electron Devices - Working Group A  
Palisades Institute for Research Services  
1745 Jefferson Davis Highway, Suite 500  
Arlington, VA 22202-3702, U.S.A.

## Questions and Answers

**RONALD L. BEARD (NRL):** Given the general mood of DoD to moving towards using commercial standards and getting away from military requirements, do you feel this is an area where adopting civilian or commercial standards might be practical?

**JOHN R. VIG (ARMY RESEARCH LAB):** I'll tell you my favorite story about the subject which some of you may already have heard. I was attending a NATO meeting a number of years ago, and we were discussing this subject over dinner. One of my colleagues — I think he was from the Netherlands — said that their defense department, some bean counter, was looking at purchases; and he noticed that the Dutch Navy was buying 40-watt light bulbs for \$10 apiece. And he said "Why are we doing this?" Nobody could answer. So he put in a suggestion saying "We should buy commercial. I could go down to the corner hardware store and buy light bulbs for three for a dollar."

His suggestion was adopted. He got a big award for saving money for the Dutch Navy. Gradually, all the light bulbs were replaced with these commercial light bulbs. Then they went out on NATO exercise, and were somewhere in the middle of the Indian Ocean when the command came, "Fire!" And all the lights went out.

They had one set of replacements, so they put in all the replacements. And the command came again, "Fire!" And all the light bulbs went out again. And then the commander had to meekly ask the permission to go home to get more light bulbs.

But the answer to the question is obviously there are some areas where commercial products can fill the need, and obviously there are some areas where commercial products cannot meet the need. Commercial products are not made to be radiation-hardened. So if you want to send an oscillator into space, the commercial products are definitely not the way to go. You need a radiation-hardened oscillator to send into space. Depending on what you envision for the scenario for future wars, you may or may not want to rad-harden tactical oscillators.

Things like vibrationless phase noise, things like gun-hardened oscillators — I mean, there are definitely some strictly DoD requirements which the commercial business will never address. There are no commercial requirements for an oscillator to be fired from a Howitzer. So if the DoD needs an oscillator that has to be fired from a Howitzer, the DoD better be prepared to pay for development of such an oscillator; otherwise, it will not be there.

**HARRY PETERS (SIGMA TAU STANDARDS CORPORATION):** Your chart of frequency standards and the amount expended on them in the potential market indicated H-masers estimated at 10 per year, and a nominal price of around 200k. The list of companies who produced these various standards which you put up there perhaps might have noted that the only commercial supplier of atomic H-masers in the West, that is, particularly those that have cavity tuning systems — at Sigma Tau Standards Corporation we have over 40 H-masers oscillating and a few more in the building stage at this time; and of course, there's been no government-funded research on H-masers within this company for the last 10 years. However, there has been input of funds from what is generated from profits; and all our research has been internal since 1985, but I think at least we might have merited a mention in your list of monies that are applied to research in frequency standards. I notice you didn't notice Sigma

Tau Standards Corporation. Thank you.

**JOHN VIG (ARMY RESEARCH LAB):** I said there were a number of companies under \$50 million that were not listed. So I apologize for not mentioning Sigma Tau. But the number I listed was 10 per year. So if you've built a total of 40, that doesn't seem to contradict the total production on the order of 10 per year, does it?

**HARRY PETERS (SIGMA TAU STANDARDS CORPORATION):** [Inaudible].

**JOHN VIG (ARMY RESEARCH LAB):** Okay, so it's even less than 10 per year. So I overestimated.

**DR. GERNOT WINKLER (USNO, RETIRED):** If you look at your horror stories, I think the overriding importance of communication is obvious. All of these things happened because we did not know about — I mean, systems engineers, system planners and system managers did not realize that it was a specific area, a special area requiring special knowledge and so on, the PTTI Conference, and Frequency Control Symposium and so on. Now the question is: Has this been discussed by that adjunct group? That the greatest improvement or the greatest savings could be accomplished if you get these system managers into the conferences?

**JOHN VIG (ARMY RESEARCH LAB):** Yes, it was discussed. In fact, unfortunately, as I pointed out, not only is there no incentive for a major contractor to come to a government lab, there's an incentive for them not to come to a government lab; because, government labs oftentimes are looked on as competitors. If Milstar's a problem, and the task of solving the problem goes to a government lab, Lockheed and TRW and Hughes Aircraft and Frequency Electronics don't make a profit. If Lockheed puts in a proposal for Lockheed to solve the problem, then Lockheed gets the money instead of government labs.

So in a sense, unfortunately, I'm not sure what to do about it, but the contractors look at government labs as competitors. And they have a disincentive for sending these problems to the government labs for solutions.

**DR. GERNOT WINKLER (USNO, RETIRED):** We are talking about the conferences, not the laboratories.

**JOHN VIG (ARMY RESEARCH LAB):** The conferences do address these questions, but unfortunately we can't get the systems people to attend these conferences. Okay? So again, we recognize the problem; we offer tutorials; we offer review papers; but the systems people, with a few exceptions, generally do not attend our conferences. If anybody has a solution to the problem, I would be more than happy to discuss it and listen to suggestions. But this is a problem — I think it all ties together, with the lack of university curricula, lack of communication, it often costs lots and lots of dollars.

The total budget of my group, for example, is on the order of a million dollars a year or less. This year it's less, a lot less. If you look at the cost of some of these problems, the cost of one of these major problems could fund frequency control research in the government indefinitely; you just take the money, put it in the bank, draw interest on it, and use that interest to fund the research. Again, it is not clear what we can do about it.